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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF:

Signe UNVERRICHT, et al.

: GROUP ART UNIT: 1625

SERIAL NO.: 09/936,184

:

FILED: September 10, 2001

: EXAMINER: T. OH

FOR: CATALYTIC GAS-PHASE OXIDATION OF PROPENE TO ACRYLIC ACID

APPEAL BRIEF

COMMISSIONER FOR PATENTS
ALEXANDRIA, VA 22313-1450

SIR:

This is an appeal from the Examiner's Final Rejection dated October 22, 2003, of Claims 1-31. A Notice of Appeal was timely filed on January 22, 2004.

I. REAL PARTY IN INTEREST

The real parties in interest BASF Aktiengesellschaft, by assignment recorded March 5, 2002 at Reel/Frame 012629/0814.

II. RELATED APPEALS AND INTERFERENCES

Appellants, Appellants' legal representative and their assignee are not aware of any appeals or interferences which will directly affect or be directly affected by or having a bearing on the Board's decision in this appeal.

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III. STATUS OF THE CLAIMS

The appealed claims are Claims 1-31, the only claims in the case.

IV. THE APPEALED CLAIMS

A copy of the appealed claims is submitted in the attached Appendix I.

V. SUMMARY OF THE INVENTION

Acrylic acid is an important monomer which is used as such or in the form of its alkyl esters for producing, for example, polymers suitable as adhesives. The present invention relates to a process for the catalytic gas-phase oxidation of propene to acrylic acid (specification, page 1, lines 4-31) in two stages in a fixed-bed reactor.

The two-stage fixed-bed gas-phase oxidation of propene to acrylic acid should achieve a very high space-time yield of acrylic acid. This is the total amount of acrylic acid produced per hour and total volume of the catalyst bed used, in liters, in the case of a continuous process. It is desirable to have a very high loading of the first fixed catalyst bed with propene and a very high loading of the second fixed catalyst bed with acrolein, without significantly impairing a) the conversion with respect to propene and acrolein which takes place during a single pass of the reaction gas starting mixture through the two fixed catalyst beds and b) the selectivity of the associated acrylic acid formation, balanced over both reaction stages, based on propene converted.

The realization of the abovementioned is adversely affected because both the fixed-bed gas-phase oxidation of propene to acrolein and the fixed-bed gas-phase oxidation of acrolein to

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acrylic acid are highly exothermic and are accompanied by a variety of possible simultaneous and subsequent reactions. With increasing propene or acrolein loading of the respective fixed catalyst bed, the selectivity of the formation of desired product decreases as a result of increased heat production.

However, according to the present invention, a two-stage gas-phase oxidation of propene to acrylic acid, in which both a high propene loading and a high acrolein loading of the respective fixed-bed catalyst are used in the two oxidation stages, is achieved as follows:

A reaction gas starting mixture 1 which comprises molecular oxygen and propene in a molar $O_2:C_3H_6$ ratio of ≥ 1 , and at least one inert gas which comprises at least 20% by volume of molecular nitrogen, is passed in a first reaction stage at elevated temperatures, over a first fixed-bed catalyst, whose active material is at least one multimetal oxide comprising molybdenum and/or tungsten and bismuth, tellurium, antimony, tin and/or copper. A product gas mixture 1 is obtained. The reaction gas starting mixture 1 is passed over the fixed-bed catalyst in such a way that the propene conversion in a single pass is ≥ 90 mol%, an associated selectivity of the acrolein formation and of the acrylic acid byproduct formation together is ≥ 90 mol%. The product gas mixture 1, is passed as reaction gas starting mixture 2 which comprises molecular oxygen and acrolein in a molar $O_2:C_3H_4O$ ratio of ≥ 0.5 , and at least one inert gas which comprises at least 20% by volume of molecular nitrogen, in a second reaction stage at elevated temperatures, over a second fixed-bed catalyst whose active material which is at least one molybdenum- and vanadium-containing multimetal oxide. A product gas mixture 2 is obtained. The the reaction gas starting mixture 2 is passed over the second fixed-bed catalyst in such away that an acrolein conversion in a single pass is ≥ 90 mol%, and the

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selectivity of the acrylic acid formation balanced over both reaction stages is ≥ 80 mol%, based on propene converted. A loading of the first fixed-bed catalyst with the propene contained in reaction gas starting mixture 1 is ≥ 160 l(S.T.P.) of propene/l of catalyst bed \cdot h. The first fixed-bed catalyst comprises a catalyst bed arranged in two spatially successive reaction zones A, and B. The temperature of reaction zone A is from 300 to 390°C and a temperature of reaction zone B is from 305 to 420°C and at the same time at least 5°C above the temperature of reaction zone A. The reaction gas starting mixture 1 flows first through reaction zone A and then through reaction zone B. The reaction zone A extends to a propene conversion of from 40 to 80 mol%. A loading of the second fixed-bed catalyst with the acrolein contained in reaction gas starting mixture 2 is ≥ 140 l(S.T.P.) of acrolein/l of catalyst bed \cdot h. The second fixed-bed catalyst comprises a catalyst bed arranged in two spatially successive reaction zones C, and D. The temperature of reaction zone C is from 230 to 270°C and a temperature of reaction zone D is from 250 to 300°C and at the same time at least 5°C above the temperature of reaction zone C. The reaction gas starting mixture 2 flows first through reaction zone C and then through reaction zone D. The reaction zone C extends to an acrolein conversion of from 55 to 85 mol%.

Claim 1 finds basis at page 1, lines 4-31 and at page 5, line 4 to page 6, line 19 of the specification.

Claim 2 finds basis at page 5, lines 21 and 22 of the specification.

Claim 3 finds basis at page 5, lines 21 and 22 of the specification.

Claim 4 finds basis at page 18, lines 18 and 19 of the specification.

Claim 5 finds basis at page 6, lines 27-29 of the specification.

Claim 6 finds basis at page 18, lines 20-22 of the specification.

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Claim 7 finds basis at page 6, lines 24 and 25 of the specification.

Claim 8 finds basis at page 6, lines 24-26 of the specification.

Claim 9 finds basis at page 18, lines 19 and 20 of the specification.

Claim 10 finds basis at page 18, lines 20-22 of the specification.

Claim 11 finds basis at page 6, lines 40-42 of the specification.

Claim 12 finds basis at page 6, lines 42-45 of the specification.

Claim 13 finds basis at page 18, lines 34-36 of the specification.

Claim 14 finds basis at page 20, lines 1-5 of the specification.

Claim 15 finds basis at page 7, line 2 of the specification.

Claim 16 finds basis at page 7, lines 2 and 3 of the specification.

Claim 17 finds basis at page 7, lines 10-15 of the specification.

Claim 18 finds basis at page 7, lines 10-15 of the specification.

Claim 19 finds basis at page 7, line 19 of the specification.

Claim 20 finds basis at page 7, lines 19 of the specification.

Claim 21 finds basis at page 8, lines 11-14 of the specification.

Claim 22 finds basis at page 9, lines 5-28 of the specification.

Claim 23 finds basis at page 11, line 42 to page 12, line 34 of the specification.

Claim 24 finds basis at page 10, line 45 to page 11, line 4 and at page 11, lines 20-40 of the specification.

Claim 25 finds basis at page 10, line 45 to page 11, line 4 of the specification.

Claim 26 finds basis at page 11, lines 6-40 of the specification.

Claim 27 finds basis at page 13, lines 45-47 of the specification.

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Claim 28 finds basis at page 20, lines 21-43 of the specification.

Claim 29 finds basis at page 23, line 44 to page 24, last line, of the specification.

Claims 30 and 31 find basis at page 22, line 34 to page 23, line 42 of the specification.

VI. THE ISSUE OF THIS APPEAL

1. Whether, Claims 1-22, 27 and 28 are obvious under 35 U.S.C. §103(a) over Ruppel et al (US 5,821,390), in view of Ruppel et al (US 5,739,391) and Etzkorn et al (US 5,198,578)?

2. Whether, Claims 1, 23-24, 29 and 30-31 are obvious under 35 U.S.C. §103(a) over Ruppel et al (US 5,821,390), in view of Ruppel et al (US 5,739,391), Neumann et al (U.S. 5,364,825) and Etzkorn et al (US 5,198,578)?

3. Whether Claims 1, 22-23 and 28-29 are not enabled by the specification under 35 U.S.C. §112, 1st paragraph?

VII. GROUPING OF THE CLAIMS

Issue 1: Group I: Claims 1-22, 27 and 28.

Issue 2: Group I: Claims 1, 23, 24, 29, 30 and 31.

Issue 3: Group I: Claims 1, 22, 23, 28 and 29.

VIII. ARGUMENTS IN TRAVERSAL OF THE REJECTION

1. Claims 1-22, 27 and 28 stand rejected as obvious under 35 U.S.C. §103(a) over Ruppel et al (US 5,821,390), in view of Ruppel et al (US 5,739,391) and Etzkorn et al (US 5,198,578).

None of Ruppel et al (US 5,821,390), Ruppel et al (US 5,739,391) and Etzkorn et al

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(US 5,198,578) alone or in combination disclose or suggest the claimed process.

Notably, in the process of the present invention, a reaction gas starting mixture 1 of molecular oxygen, propene and at least one inert gas passes in a first reaction stage at elevated temperatures over a first fixed-bed catalyst. In this step, propene is converted to acrolein. **A loading of the first fixed-bed catalyst with the propene contained in reaction gas starting mixture 1 is ≥ 160 l(S.T.P.) of propene/l of catalyst bed \cdot h. The first fixed-bed catalyst comprises a catalyst bed arranged in two spatially successive reaction zones A and B. The temperature of reaction zone A is from 300 to 390°C and the temperature of reaction zone B is from 305 to 420°C. The temperature of reaction zone B is at least 5°C above the temperature of reaction zone A. The reaction gas starting mixture 1 flows first through reaction zone A and then through reaction zone B. The reaction zone A extends to a propene conversion of from 40 to 80 mol%.**

The resulting product gas mixture 1 is used as reaction gas starting mixture 2 and contains molecular oxygen, acrolein and at least one inert gas. Reaction gas starting mixture 2 passes in a second reaction stage at elevated temperatures over a second fixed-bed catalyst. In this step, acrolein is converted to acrylic acid. **The loading of the second fixed-bed catalyst with the acrolein contained in reaction gas starting mixture 2 is ≥ 140 l(S.T.P.) of acrolein/l of catalyst bed \cdot h. The second fixed-bed catalyst comprises a catalyst bed arranged in two spatially successive reaction zones C and D. The temperature of reaction zone C is from 230 to 270°C and the temperature of reaction zone D is from 250 to 300°C. The temperature of reaction zone D is at least 5°C above the temperature of reaction zone C. The reaction gas starting mixture 2 flows first through reaction zone C and then through**

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reaction zone D. The reaction zone C extends to an acrolein conversion of from 55 to 85 mol%. The selectivity of the acrylic acid formation balanced over both reaction stages is ≥ 80 mol%, based on propene converted.

Ruppel et al (US 5,821,390) fail to disclose or suggest

1) reaction stage two of the present invention, the conversion of acrolein to acrylic acid, **in its entirety**. With regard to the first reaction stage, the conversion of propene to acrolein, Ruppel et al (US 5,821,390) fail to disclose or suggest that

2) the loading of the first fixed-bed catalyst with the propene contained in reaction gas starting mixture 1 is ≥ 160 l(S.T.P.) of propene/l of catalyst bed \cdot h, that

3) the first fixed-bed catalyst comprises a catalyst bed arranged in two spatially successive reaction zones A and B, that

4) the temperature of reaction zone A is from 300 to 390°C and the temperature of reaction zone B is from 305 to 420°C, that

5) the temperature of reaction zone B is at least 5°C above the temperature of reaction zone A, that

6) the reaction gas starting mixture 1 flows first through reaction zone A and then through reaction zone B, that

7) the reaction zone A extends to a propene conversion of from 40 to 80 mol%, and that

8) the selectivity of the acrylic acid formation balanced over both reaction stages is ≥ 80 mol%, based on propene converted.

Ruppel et al (US 5,821,390) discloses the catalytic gas-phase oxidation of propene to

acrolein (abstract). A multiple contact tube fixed-bed reactor is used. The reactor 1 is shown in the Figure of Ruppel et al. A reactant gas mixture comprising propene and oxygen enters lower bonnet 6 through line 11 and flows through the catalyst containing contact tubes 2 in cocurrent flow with the heat-exchange medium. Gaseous reaction products are collected in upper bonnet 5 and pass from the reactor through exit line 10 (col. 6, lines 13-18).

However, the multiple contact tube fixed-bed reactor of Ruppel et al (US 5,821,390) does not have the claimed two spatially successive reaction zones A and B in which the temperature of reaction zone B is at least 5°C above the temperature of reaction zone A and wherein the reaction zone A extends to a propene conversion of from 40 to 80 mol%. In fact, Ruppel et al (US 5,821,390) cannot have two spatially successive reaction zones as the reaction is performed in a multiple contact tube fixed-bed reactor through whose space surrounding the contact tubes **only one heat-exchange medium** circuit is passed (col. 4, lines 12-15). The heat-exchange medium is firstly passed longitudinally through the multiple contact fixed-bed reactor to the contact tubes in cocurrent to the reaction gas mixture. Secondly, a transverse flow is superposed within the reaction containers by means of an arrangement of successive baffles along the contact tubes, so as to give a meandrous flow of the heat exchange medium, seen in longitudinal section through the tube bundle. The flow rate of the circulated heat-exchange medium is set so that its temperature rises by from 2 to 10 ° C, between the point of entry into the reactor and the point of exit out of the reactor (col. 4, lines 17-31). The rise of the temperature is caused by the exothermic reaction and is continuous throughout the reactor. There are no two spatially successive reaction zones A and B in which the temperature of reaction zone B is at least 5°C above the temperature of reaction zone A and wherein the

reaction zone A extends to a propene conversion of from 40 to 80 mol%.

On the other hand, **in the present invention, two separate heat-exchange media are used** allowing for two spatially successive reaction zones A and B in which the temperature of reaction zone B is at least 5°C above the temperature of reaction zone A and wherein the reaction zone A extends to a propene conversion of from 40 to 80 mol%. The specification states at page 14, lines 7-22 as follows:

In other words, in the simplest procedure, the fixed-bed catalyst 1 to be used according to the invention is present in the metal tubes of the tube-bundle reactor, and two thermostating media, as a rule salt melts, essentially spatially separated from one another are passed around the metal tubes. The tube section over which the respective salt bath extends represents, according to the invention, a reaction zone, i.e. in the simplest procedure a salt bath A flows around that section of the tubes (the reaction zone A) in which the oxidative conversion of the propene (in a single pass) up to a conversion of from 40 to 80 mol% takes place, and a salt bath B flows around that section of the tube (reaction zone B), in which the subsequent oxidative conversion of the propene (in a single pass) to a conversion of at least 90 mol% takes place (if necessary, the reaction zones A,B to be used according to the invention may be followed by further reaction zones which are kept at individual temperatures).

The Examiner cites Ruppel et al (US 5,739,391) to cure the defects of Ruppel et al (US 5,821,390). Ruppel et al (US 5,739,391) fail to disclose or suggest

9) the first stage of the claimed process in its entirety, and that

10) the loading of the second fixed-bed catalyst with the acrolein contained in reaction gas starting mixture 2 is ≥ 140 l(S.T.P.) of acrolein/l of catalyst bed \cdot h, that

11) the second fixed-bed catalyst comprises a catalyst bed arranged in two spatially successive reaction zones C and D, that

12) the temperature of reaction zone C is from 230 to 270°C and the temperature of

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reaction zone D is from 250 to 300°C, that

13) the temperature of reaction zone D is at least 5°C above the temperature of reaction zone C, that

14) the reaction gas starting mixture 2 flows first through reaction zone C and then through reaction zone D, that

15) the reaction zone C extends to an acrolein conversion of from 55 to 85 mol%, and that

16) the selectivity of the acrylic acid formation balanced over both reaction stages is ≥ 80 mol%, based on propene converted.

Since Ruppel et al (US 5,739,391) fail to disclose or suggest the first stage of the claimed process in its entirety, it cannot cure the defects **1)-8)** of Ruppel et al (US 5,821,390) with respect to the first stage. Even if Ruppel et al (US 5,739,391) and Ruppel et al (US 5,821,390) were combined, the combination would still lack limitations **1)-16)** as claimed. Moreover, the alleged combination cannot have the claimed two spatially successive reaction zones A and B in which the temperature of reaction zone B is at least 5°C above the temperature of reaction zone A and wherein the reaction zone A extends to a propene conversion of from 40 to 80 mol% and two spatially successive reaction zones C and D in which the temperature of reaction zone D is at least 5°C above the temperature of reaction zone C and wherein the reaction zone C extends to an acrolein conversion of from 55 to 85 mol%.

Ruppel et al (US 5,739,391) disclose a process for the catalytic gas-phase oxidation of acrolein to acrylic acid (abstract). Again, the reaction is performed in a multiple contact tube fixed-bed reactor through whose space surrounding the contact tubes **only one heat-exchange**

medium circuit is passed (col. 3, lines 40-44). Thus, this reference cannot have two spatially successive reaction zones C and D in which the temperature of reaction zone D is at least 5°C above the temperature of reaction zone C and wherein the reaction zone C extends to an acrolein conversion of from 55 to 85 mol%.

On the other hand, **in the present invention, two separate heat-exchange media are used** allowing for two spatially successive reaction zones C and D in which the temperature of reaction zone D is at least 5°C above the temperature of reaction zone C and wherein the reaction zone C extends to an acrolein conversion of from 55 to 85 mol%. The specification states at page 25, line 40 to page 26, line 12 as follows:

In other words, in a simple procedure, the fixed-bed catalyst to be used according to the invention is present in the metal tubes of a tube-bundle reactor, and two thermostating media, as a rule salt melts, which are essentially spatially separated from one another are passed around the metal tubes. The tube section over which the respective salt bath extends represents, according to the invention, a reaction zone.

In other words, in a simple procedure, a salt bath C flows around those sections of the tubes (the reaction zone C) in which the oxidative conversion of the acrolein (in a single pass) to a conversion of from 55 to 85 mol% takes place, and a salt bath D flows around the section of the tubes (the reaction zone D) in which the subsequent oxidative conversion of the acrolein (in a single pass) takes place to a conversion of at least 90 mol% (if required, the reaction zones C, D to be used according to the invention may be followed by further reaction zones which are kept at individual temperatures).

Etzkorn et al (US 5,198,578) also fails to cure the defects of the two Ruppel et al references, as there is no disclosure or suggestion of features 1)-16) of the present invention. Etzkorn et al disclose a process for the oxidation of propylene to acrylic acid in two stages with acrolein as an intermediate (abstract). Moreover, the alleged combination cannot have the claimed two spatially successive reaction zones A and B in which the temperature of reaction

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zone B is at least 5°C above the temperature of reaction zone A and wherein the reaction zone A extends to a propene conversion of from 40 to 80 mol% and two spatially successive reaction zones C and D in which the temperature of reaction zone D is at least 5°C above the temperature of reaction zone C and wherein the reaction zone C extends to an acrolein conversion of from 55 to 85 mol%. The alleged combination only provides for the use of one heat exchange medium.

Etzkorn et al employ in **one** temperature zone only such **small propene load** as **112 l/l/h** (column 13, line 15, total load = 1600 l/l/h, and the propene concentration is 7% (column 12, lines 30 and 54), (7% of 1600 equals 112).

In Summary, the present invention relates to a process for the catalytic gas-phase oxidation of propene to acrylic acid in which **two salt baths, two temperature zones** are used, thus enabling **high reactant loads** without losing product. Under the claimed temperature structure of the process it is possible to significantly increase the **propene and acrolein load** (≥ 160 l(S.T.P.) of propene/l of catalyst bed · h, and ≥ 140 l(S.T.P.) of acrolein/l of catalyst bed · h) of the catalysts without suffering significant product losses and thus achieving a **space-time-yield being double and more** compared to that in the prior art. This high space-time yield is achieved in the same reaction tube and with the same amount of catalyst. Twice as much product or more can be produced in the same time compared with using the same catalyst amount in the same tube but under the prior art temperature structure and load.

Thus, none of Ruppel et al (US 5,821,390), Ruppel et al (US 5,739,391) and Etzkorn et al (US 5,198,578) alone or in combination disclose or suggest the claimed process. There is no motivation or suggestion to modify the processes of the references to arrive at the claimed

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invention.

Thus, Claims 1-22, and 27-28 are Not Obvious over Ruppel et al (US 5,821,390) in view of Ruppel et al (US 5,739,391) and Etzkorn et al (US 5,198,578) within the meaning of 35 U.S.C. §103(a).

2. Claims 1, 23-24, 29 and 30-31 stand rejected as obvious under 35 U.S.C. §103(a) over Ruppel et al (US 5,821,390), in view of Ruppel et al (US 5,739,391), Neumann et al (U.S. 5,364,825) and Etzkorn et al (US 5,198,578).

The combination of Ruppel et al (US 5,821,390), Ruppel et al (US 5,739,391) and Etzkorn et al (US 5,198,578) has been discussed above. Neumann et al do not cure the defects of these references as they fail to disclose or suggest features 1)-16) of the present invention. In fact, the Examiner has merely cited this reference to show catalysts for the preparation of carboxylic acids. See Office Action of May 7, 2003, starting at page 13.

In addition, Neumann et al apply only small loads in one reaction zone. For example, 5% of 2400 equals 120 (see column 6, line 7 of Neumann et al (U.S. 5,364,825). Thus, Neumann et al does nothing to cure the defects of Ruppel et al (US 5,821,390), Ruppel et al (US 5,739,391), and Etzkorn et al (US 5,198,578), and even a combination of the references does not result in the claimed invention.

Thus, Claims 1, 23-24, 29, 30-31 are Not Obvious over Ruppel et al (US 5,821,390) in view of Ruppel et al (US 5,739,391), Neumann et al (U.S. 5,364,825) and Etzkorn et al (US 5,198,578) within the meaning of 35 U.S.C. §103(a).

3. Claims 1, 22-23 and 28-29 stand rejected as being not enabled by the specification under 35 U.S.C. §112, 1st paragraph.

Contrary to the Examiner's allegation, the specification provides on a total of 12 pages a large number of details regarding catalyst I and catalyst II. Specifically, page 8, line 24 to page 13, line 43 and page 20, line 7 to page 25, line 10, disclose details about the catalysts to be used and their methods of making. In addition, Examples of the catalyst preparation have been provided in the specification. These details are sufficient to enable the person of ordinary skill in the art to perform the claimed process without undue experimentation.

Applicants would like to put emphasis on the fact, that the present application claims a process using catalysts which are well-known in the art for a long period of time and which are even described in the references cited by the Examiner (e.g. US - A 2941007, US - A 5739391, US - A 5364825, US - A 6198580 and US - A 5380933). Also, the suitability of such catalysts for the generic reaction type is well-known in said references and other literature. In fact, Etzkorn et al (US 5,198,578) point out that the independence from a particular catalyst (col. 9, lines 8-11). Thus, manufacture and applicability of the catalysts recommended in the current application for the process as claimed cannot be disputed.

In addition, the present application not only shows Examples in which representative catalysts are used, moreover, the specification specifically names further individual catalyst compositions which are especially favorable in the respective stages (e.g. page 8, line 28 to page 9 or on page 20 in line 19 of the specification).

This detailed disclosure of applicable catalysts certainly is not less than in US - A 5198578 (see column 9, line 8 to 20 of that reference cited by the Examiner) whose disclosure obviously sufficiently enabled the skilled artisan (the Examples of that reference even do not contain any explicit disclosure of the catalyst employed (see column 11, lines 62 following of

that reference) which in view of the USPTO was enough for grant.

Furthermore the representative Examples of the present application undisputedly prove that under the claimed temperature structure of the process it is possible to significantly increase the propene and acrolein load of the catalysts without suffering significant product losses and thus achieving a **space-time-yield being double** and more than that in the prior art (in the same reaction tube and with the same amount of catalyst twice as much product can be produced in the same time compared with using the same catalyst amount in the same tube but under the old temperature structure and load).

Even assuming that some catalysts or catalyst combinations will not perform identically, when a catalyst or catalyst combination performs poor it will generally do so under the prior art and under the claimed conditions. Nevertheless, the poorer space-time-yield with a poor performing catalyst or catalyst combination under the claimed process conditions will be about twice as much or more of the poor space-time-yield achievable using the same poor catalyst or catalyst combination under the prior art process conditions. Thus, a person of ordinary skill in the art is clearly enabled to perform the claimed process without undue experimentation. Thus, this rejection should be withdrawn.

Thus, Claims 1, 22-23 and 28-29 are enabled by the specification within the meaning of 35 U.S.C. §112, 1st paragraph.

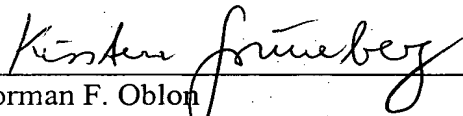
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IX. RELIEF REQUESTED

Reversal of the Examiner's rejections of the appealed claims under 35 U.S.C. §103(a) and 35 U.S.C. §112, 1st paragraph, is requested.

Respectfully submitted,

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APPENDIX I

The appealed claims read as follows:

1. A process for the catalytic gas-phase oxidation of propene to acrylic acid, comprising:
 - passing a reaction gas starting mixture 1 which comprises molecular oxygen and propene in a molar O_2 : C_3H_6 ratio of ≥ 1 , and at least one inert gas which comprises at least 20% by volume of molecular nitrogen, in a first reaction stage at elevated temperatures, over a first fixed-bed catalyst, whose active material is at least one multimetal oxide comprising molybdenum and/or tungsten and bismuth, tellurium, antimony, tin and/or copper, thereby obtaining a product gas mixture 1;
 - wherein said passing of said reaction gas starting mixture 1 proceeds in such a way that a propene conversion in a single pass is ≥ 90 mol%,
 - an associated selectivity of an acrolein formation and of an acrylic acid byproduct formation together is ≥ 90 mol%,
 - optionally, a temperature of said product gas mixture 1 leaving said first reaction stage is reduced by indirect and/or direct cooling, and
 - optionally, molecular oxygen and/or inert gas are/is added to said product gas mixture 1, and
 - passing said product gas mixture 1, as reaction gas starting mixture 2 which comprises molecular oxygen and acrolein in a molar O_2 : C_3H_4O ratio of ≥ 0.5 , and at least one inert gas which comprises at least 20% by volume of molecular nitrogen, in a second reaction stage at

elevated temperatures, over a second fixed-bed catalyst whose active material is at least one molybdenum- and vanadium-containing multimetal oxide,

thereby obtaining a product gas mixture 2,

wherein said passing of said reaction gas starting mixture 2 proceeds in such away that

an acrolein conversion in a single pass is ≥ 90 mol%,

the selectivity of the acrylic acid formation balanced over both reaction stages is ≥ 80 mol%, based on propene converted;

wherein

- a) a loading of said first fixed-bed catalyst with the propene contained in reaction gas starting mixture 1 is ≥ 160 l(S.T.P.) of propene/l of catalyst bed \cdot h,
- b) said first fixed-bed catalyst comprises a catalyst bed arranged in two spatially successive reaction zones A, B,
wherein a temperature of reaction zone A is from 300 to 390°C and a temperature of reaction zone B is from 305 to 420°C and at the same time at least 5°C above the temperature of reaction zone A,
- c) the reaction gas starting mixture 1 flows first through reaction zone A and then through reaction zone B,
- d) the reaction zone A extends to a propene conversion of from 40 to 80 mol%,
- e) a loading of said second fixed-bed catalyst with the acrolein contained in reaction gas starting mixture 2 is ≥ 140 l(S.T.P.) of acrolein/l of catalyst bed \cdot h,
- f) said second fixed-bed catalyst comprises a catalyst bed arranged in two spatially

successive reaction zones C,D,

wherein a temperature of reaction zone C is from 230 to 270°C and a

temperature of reaction zone D is from 250 to 300°C and at the same time at

least 5°C above the temperature of reaction zone C,

- g) the reaction gas starting mixture 2 flows first through reaction zone C and then through reaction zone D, and
- h) the reaction zone C extends to an acrolein conversion of from 55 to 85 mol%.

2. A process as claimed in claim 1, wherein the reaction zone A extends to a propene conversion of from 50 to 70 mol%.

3. A process as claimed in claim 1, wherein the reaction zone A extends to a propene conversion of from 65 to 75 mol%.

4. A process as claimed in claim 1, wherein the reaction zone C extends to an acrolein conversion of from 65 to 80 mol%.

5. A process as claimed in claim 1, wherein the temperature of the reaction zone B is at least 10°C above the temperature of the reaction zone A.

6. A process as claimed in claim 1, wherein the temperature of the reaction zone D is at least 20°C above the temperature of the reaction zone C.

7. A process as claimed in claim 1, wherein the temperature of the reaction zone B is from 305 to 340°C.

8. A process as claimed in claim 1, wherein the temperature of the reaction zone B is from 310 to 330°C.

9. A process as claimed in claim 1, wherein the temperature of the reaction zone C is from 245 to 260°C.

10. A process as claimed in claim 1, wherein the temperature of the reaction zone D is from 265 to 285°C.

11. A process as claimed in claim 1, wherein the propene conversion in a single pass in the first reaction stage is ≥ 94 mol%.

12. A process as claimed in claim 1, wherein the selectivity of the acrolein formation and of the acrylic acid byproduct formation together in a single pass in the first reaction stage is ≥ 94 mol%.

13. A process as claimed in claim 1, wherein the acrolein conversion in a single pass in the second reaction stage is ≥ 94 mol%.

14. A process as claimed in claim 1, wherein the selectivity of the acrylic acid

formation balanced over both reaction stages is ≥ 85 mol%, based on propene converted.

15. A process as claimed in claim 1, wherein the propene loading of the first fixed-bed catalyst is ≥ 165 l(S.T.P.)/l · h.

16. A process as claimed in claim 1, wherein the propene loading of the first fixed-bed catalyst is ≥ 170 l(S.T.P.)/l · h.

17. A process as claimed in claim 1, wherein the at least one inert gas contained in the reaction gas starting mixture 1 comprises $\geq 40\%$ by volume of molecular nitrogen.

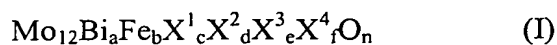
18. A process as claimed in claim 1, wherein the at least one inert gas contained in the reaction gas starting mixture 1 comprises $\geq 60\%$ by volume of molecular nitrogen.

19. A process as claimed in claim 1, wherein the at least one inert gas contained in the reaction gas starting mixture 1 comprises steam.

20. A process as claimed in claim 1, wherein the at least one inert gas contained in the reaction gas starting mixture 1 comprises CO₂ and/or CO.

21. A process as claimed in claim 1, wherein the propene content of the reaction gas starting mixture 1 is from 4 to 15% by volume.

22. A process as claimed in claim 1, wherein the active material of the first fixed-bed catalyst is at least one multimetal oxide of the formula I



where

X^1 is nickel and/or cobalt,

X^2 is thallium, an alkali metal and/or an alkaline earth metal,

X^3 is zinc, phosphorus, arsenic, boron, antimony, tin, cerium, lead and/or tungsten,

X^4 is silicon, aluminum, titanium and/or zirconium,

a is from 0.5 to 5,

b is from 0.01 to 5,

c is from 0 to 10,

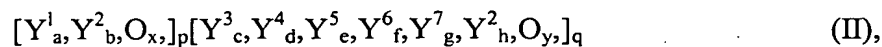
d is from 0 to 2,

e is from 0 to 8,

f is from 0 to 10 and

n is a number which is determined by the valency and frequency of the elements other than oxygen in I.

23. A process as claimed in claim 1, wherein the active material of the first fixed-bed catalyst is at least one multimetal oxide of the formula II



where

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Y^1 is bismuth, tellurium, antimony, tin and/or copper,

Y^2 is molybdenum and/or tungsten,

Y^3 is an alkali metal, thallium and/or samarium,

Y^4 is an alkaline earth metal, nickel, cobalt, copper, manganese, zinc, tin, cadmium and/or mercury,

Y^5 is iron, chromium, cerium and/or vanadium,

Y^6 is phosphorus, arsenic, boron and/or antimony,

Y^7 is a rare earth metal, titanium, zirconium, niobium, tantalum, rhenium, ruthenium, rhodium, silver, gold, aluminum, gallium, indium, silicon, germanium, lead, thorium and/or uranium,

a' is from 0.01 to 8,

b' is from 0.1 to 30,

c' is from 0 to 4,

d' is from 0 to 20,

e' is from 0 to 20,

f' is from 0 to 6,

g' is from 0 to 15,

h' is from 8 to 16,

x', y' are numbers which are determined by the valency and frequency of the elements other than oxygen in II and

p, q are numbers whose ratio p/q is from 0.1 to 10,

containing three-dimensional regions which are delimited from their local environment as a result of their composition differing from their local environment and have the chemical

composition Y_a^1, Y_b^2, O_x , and whose maximum diameters are from 1 nm to 100 μm .

24. A process as claimed in claim 1, wherein the first fixed-bed catalyst comprises annular and/or spherical catalysts.

25. A process as claimed in claim 24, wherein the ring geometry is the following:

external diameter: from 2 to 10 mm,

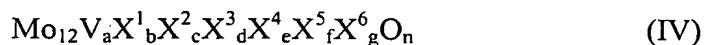
length: from 2 to 10 mm,

wall thickness: from 1 to 3 mm.

26. A process as claimed in claim 24, wherein the spherical catalyst is a coated catalyst comprising a spherical support having a diameter of from 1 to 8 mm and a coat of active material applied thereon having a thickness of from 10 to 1000 μm .

27. The process as claimed in claim 1, wherein the first and the second reaction stages are each carried out in a two-zone tube-bundle reactor.

28. A process as claimed in claim 1, wherein the active material of the second fixed-bed catalyst is at least one multimetal oxide of the formula IV



where

X^1 is W, Nb, Ta, Cr and/or Ce,

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X^2 is Cu, Ni, Co, Fe, Mn and/or Zn,

X^3 is Sb and/or Bi,

X^4 is one or more alkali metals,

X^5 is one or more alkaline earth metals,

X^6 is Si, Al, Ti and/or Zr,

a is from 1 to 6,

b is from 0.2 to 4,

c is from 0.5 to 18,

d is from 0 to 40,

e is from 0 to 2,

f is from 0 to 4,

g is from 0 to 40 and

n is a number which is determined by the valency and frequency of the elements other than oxygen in IV.

29. A process as claimed in claim 1, wherein the active material of the second fixed-bed catalyst is at least one multimetal oxide of the formula VI



where

D is $Mo_{12}V_aZ^1_bZ^2_cZ^3_dZ^4_eZ^5_fZ^6_gO_x$,

E is $Z^7_{12}Cu_hH_iO_y$,

Z^1 is W, Nb, Ta, Cr and/or Ce,

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Z^2 is Cu, Ni, Co, Fe, Mn and/or Zn,

Z^3 is Sb and/or Bi,

Z^4 is Li, Na, K, Rb, Cs and/or H,

Z^5 is Mg, Co, Sr and/or Ba,

Z^6 is Si, Al, Ti and/or Zr,

Z^7 is Mo, W, V, Nb and/or Ta,

a'' is from 1 to 8,

b'' is from 0.2 to 5,

c'' is from 0 to 23,

d'' is from 0 to 50,

e'' is from 0 to 2,

f'' is from 0 to 5,

g'' is from 0 to 50,

h'' is from 4 to 30,

i'' is from 0 to 20 and

x'', y'' are numbers which are determined by the valency and frequency of the elements other than oxygen in VI and

p, q are numbers other than zero whose ratio p/q is from 160:1 to 1:1,

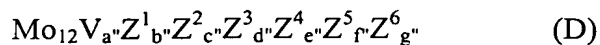
which is obtainable by separately preforming a multimetal oxide material (E)



in finely divided form (starting material 1) and then incorporating the preformed solid starting material 1 into an aqueous solution, an aqueous suspension or a finely divided dry blend of

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sources of the elements Mo, V, Z¹, Z², Z³, Z⁴, Z⁵, Z⁶, which contains the abovementioned elements in the stoichiometry D



(starting material 2), in the desired ratio p:q, drying any resulting aqueous mixture, and calcining the dry precursor material thus obtained, before or after it has been dried, at from 250 to 600°C to give the desired catalyst geometry.

30. A process as claimed in claim 1, wherein the second fixed-bed catalyst comprises annular catalysts.

31. A process as claimed in claim 1, wherein the second fixed-bed catalyst comprises spherical catalysts.